Code No: R05310304 **Set No. 1**

**III B.Tech I Semester Regular Examinations, November 2008**
**KINEMATICS OF MACHINERY**
**( Common to Mechanical Engineering, Mechatronics, Production Engineering and Automobile Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. (a) What is the difference between an element and a kinematic link of a mechanism? How do you classify links of a mechanism?
   (b) What do you mean by degree of freedom of a kinematic pair? How the pairs are classified? Give examples.
   (c) Describe elliptical trammel. Show that it can describe a true ellipse? [5+6+5]

2. In a Watt mechanism of the type shown in figure 2. The links OA and QB are perpendicular to the link AB in the mean position. If OA =40mm, QB =80mm and AB=55mm, find the point P on the link AB produced for approximate straight line motion of point p. [16]

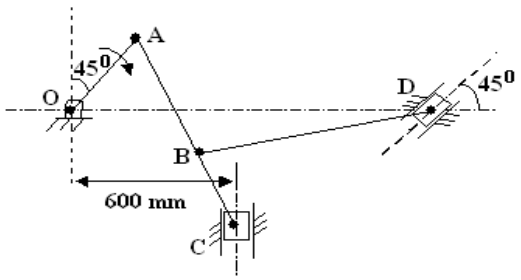


Figure 2

3. Figure 3 shows a mechanism in which OA =300 mm, AB = 600 mm, AC =BD = 1.2 m. OD is horizontal for the given configuration. If OA rotates at 200 rpm in the clockwise direction find:
   (a) the linear velocities of C and D, and
   (b) the angular velocities of links AC and BD. [8+8]

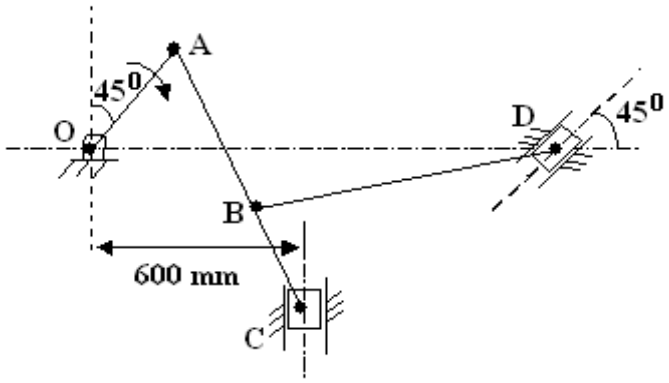


Figure 3

4. (a) Sketch polar velocity diagram of a Hooke's joint and mark its salient features.
   (b) The angle between the axes of two shafts joined by Hooke's joint is $20^o$. The driving shaft rotates at a uniform speed of 200 rpm. The driven shaft carries a steady load corresponding to a power of 7.5 kW. Calculate the mass of the flywheel of the driven shaft if its radius of gyration is 160 mm and the output torque of the driven shaft does not vary by more than 12% of the input shaft. [6+10]

5. (a) What is pressure angle with reference to cam & follower? What is it's importance?
   (b) A cam having a lift of 10mm operates the suction valve of a four stroke SI engine. The least radius of the cam is 20mm and nose radius is 2.5mm. The crank angle for the engine when suction valve opens is $4^0$ after TDC and it is $50^0$ after BDC when the suction valve closes. The crank shaft speed is 2000 rpm. The cam is of circular type with circular nose and flanks. It is integral with cam shaft and operates a flat faced follower. Estimate
      i. the maximum velocity of the valve,
      ii. the maximum acceleration and retardation of the valve, and
      iii. the minimum force to the exerted by the spring to overcome inertia of the valve parts which weight 2 N. [4+12]

6. (a) State and explain ?law of gearing?.
   (b) An internal spur gear having 200 teeth meshes with a pinion having 40 teeth and a module of 2.5mm. Determine
      i. the velocity ratio if the pinion is the driver
      ii. the centre distance, and
      iii. if the centre distance is increased by 3mm, find the resulting pressure angle. [16]

7. (a) Discuss about selection of belt drive.
   (b) A shaft runs at 80 rpm and drives another shaft at 150rpm through belt drive. The Diameter of the driving pulley is 600mm. Determine the diameter of the driven pulley in the following cases:

i. Neglecting belt thickness.
ii. Taking belt thickness as 5mm.
iii. Assuming for case (ii) a total slip of 4% and
iv. Assuming for case (ii) a slip of 2% on each pulley. [6+10]

8. (a) Explain about Epicyclic gear train.

(b) In the epicyclic gear train shown in figure 8b, a gear C which has teeth cut internally and externally is free to rotate on an arm driven by shaft $S_1$. It meshes externally with the casting D and internally with the pinion B. The gears have the following number of teeth:
$T_B = 24, T_C = 32$ *and* $40, T_D = 48$
Find the velocity ratio between

i. $S_1$ and $S_2$ when D is fixed.
ii. $S_1$ and D when $S_2$ is fixed. [4+12]

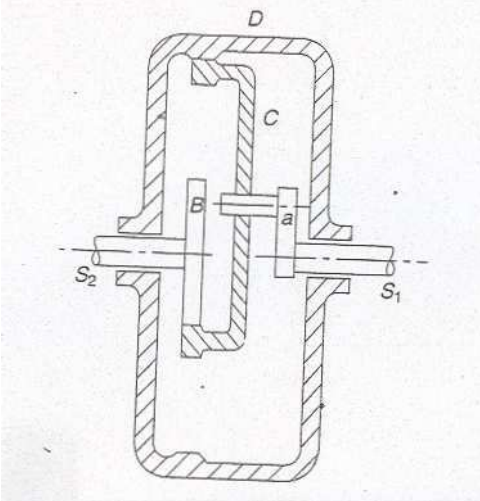


Figure 8b

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Code No: R05310304 **Set No. 2**

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1. (a) Distinguish between a structure and a machine.
   (b) Enumerate the inversions of the single slider crank chain. Explain each of them with their applications. [4+12]

2. Two points A and B, 40 mm apart are to be connected by a pantograph. The motion of A to the motion of B is 13: 7. Find the distance of B from the fixed point O of the pantograph such that the point A moves at least 12.7cm in either direction of line OBA when it is horizontal. Find also the main dimensions of the pantograph. [16]

3. In the Whitworth quick-return mechanism shown in figure 3., the dimensions of the links are: OP (crank) =240 mm, OA =150 mm, AR =165 mm and RS 450mm. The crank rotates at an angular velocity of 3 rad/s. At the moment when the crank makes an angle of $60^0$ with the vertical, calculate
   (a) the velocity of the ram S
   (b) the velocity of the slider P on the slotted lever
   (c) the angular velocity of the link RS.

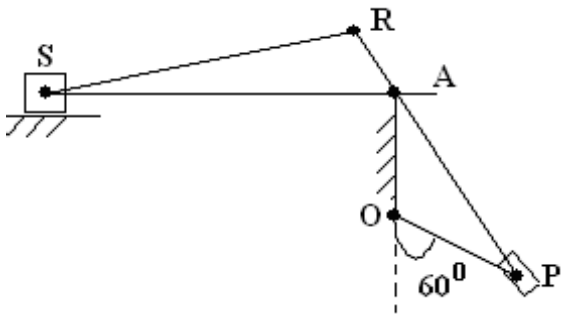


Figure 3

4. (a) Differentiate between Davis and Ackermann steering gears.
   (b) In a Davis steering gear, the length of the car between axles is 2.6 m and the steering pivots are 1.45 m apart. Determine the inclination of the track arms to the longitudinal axis of the car when it moves in a straight path.
   (c) Sketch polar velocity diagram of a Hooke's joint and mark its salient features. [6+4+6]

5. (a) Derive an expression for displacement, velocity and acceleration of a tangent cam with roller follower. When roller is in contact with flank.

   (b) A tangent cam with straight working faces tangential to a base circle of 120mm diameter has a roller follower of 48mm diameter. The line of stroke of the roller follower passes through the axis of the cam. The nose circle radius of the cam is 12mm and the angle between the tangential faces of the cam $90^0$. If the speed of the cam is 180rpm, determine the acceleration of the follower when

      i. During the lift, the roller just leaves the straight flank.

      ii. The roller is at the outer end of its lift, i.e at the top of the nose. [16]

6. (a) What is higher pair? How gears are classified?

   (b) Two gears in mesh have a module of 10mm and a pressure angle of $25^0$. The pinion has 20 teeth and the gear has 52. The addendum on both the gears is equal to one module. Determine

      i. The number of pairs of teeth in contact.

      ii. The angles of action of the pinion and the wheel.

      iii. The ratio of the sliding velocity to the rolling velocity at the pitch point and at the beginning and end of engagement. [6+10]

7. A belt is required to transmit 40kW from a pulley 1.5m diameter running at 300rpm. The angle of contact is spread over $11/24^{th}$ of the circumference of the pulley, and the coefficient of friction is 0.3, determine the width of the belt required, if thickness of belt is 10mm, safe working stress for belt material is 2.5 MPa, and density of belt material is 1100 kg/$m^3$. [16]

8. (a) Explain about automotive differential.

   (b) An epicyclic gear consists of a pinion, a wheel of 40 teeth and an annulus with 84 internal teeth concentric with the wheel. The pinion gear with the wheel and the annulus. The arm that carries the axis of the pinion rotates at 100rpm. If the annulus is fixed, find the speed of the wheel; if wheel is fixed, find the speed of the annulus. [6+10]

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Code No: R05310304 **Set No. 3**

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**Answer any FIVE Questions**
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1. (a) Define 'Machine' and 'Mechanism'. How are these different from each other?
   (b) Distinguish between structure and a machine.
   (c) Explain completely, partially and incompletely constrained motion of a kinematic pair with examples. [4+4+8]

2. (a) A coupler AB to form a simple Watt mechanism joins two bars OA and $O_1B$. When the mechanism is in its mean position, the lines OA and $O_1$B are perpendicular to AB. If OA=12cm, $O_1$B=18cm and AB=9cm, find the position of point P on connecting link which gives the best straight line motion
   (b) Sketch and Describe the Peaucellier and Hart straight-line motion mechanisms.

   [8+8]

3. In the toggle mechanism shown in figure 3., OA= 30 mm, AB= 80 mm, BC=100 mm, BD= 100 mm. Find the velocities of the points B and C and the angular velocities of links AB, BQ and BC. The crank rotates at 60 rpm in the clockwise direction. [16]

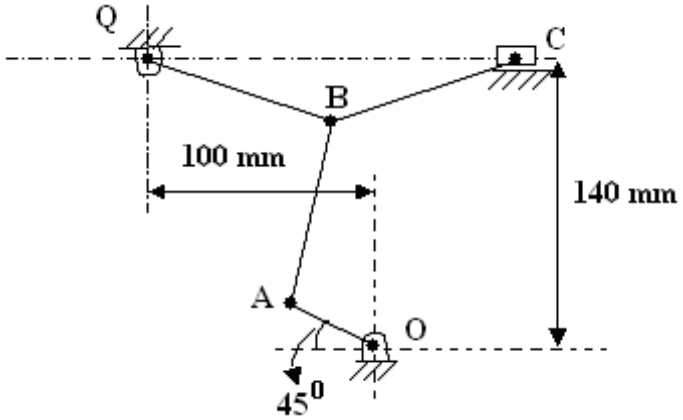


Figure 3

4. (a) What is a Hooke's joint ? What are its applications?
   (b) Determine the maximum permissible angle between the shaft axes of a universal joint if the driving shaft rotates at 600 rpm and the total fluctuation of speed does not exceed 60 rpm. Also find the maximum and minimum speeds of the driven shaft.

(c) In a double universal coupling joining two shafts, the intermediate shaft is inclined at $10^0$ to each. The input and the output forks on the intermediate shaft have been assembled inadvertently at $90^0$ to one another. Determine the maximum and the least velocities of the output shaft if the speed of the input shaft is 500rpm. Also find the coefficient of fluctuation in speed. [5+6+5]

5. (a) What is displacement diagram? How is it helpful to form a cam profile?

   (b) A tangent cam with a base circle diameter of 50mm operates a roller follower 20mm in diameter. The line of stroke of the roller follower passes through the axis of the cam. The angle between the tangential faces of the cam is $60^0$, speed of the cam shaft 200 rpm and the lift of the follower 15mm. Calculate,

   i. The main dimension of the cam.

   ii. The acceleration of the follower at

   A. The beginning of lift.

   B. Where the roller just touches the nose.

   C. The apex of the circular nose. [16]

6. (a) Give detailed classification of gears.

   (b) Two $20^0$ involute spur gears having a velocity ratio of 2.5 mesh externally. Module is 4mm and the addendum is equal to 1.23 module. Pinion rotates at 150rpm. Find

   i. The minimum number of teeth on each wheel to avoid interference.

   ii. The number of pairs of teeth in contact. [6+10]

7. A leather belt 120mm wide and 6mm thick transmits power from a pulley 800mm diameter which rotates at 450rpm. The angle of lap is $160^0$ and coefficient of friction is 0.3. The mass of the belt is 1000kg/$m^3$ and the stress is not to exceed 2.5MPa. Find the maximum power that can be transmitted. [16]

8. In an epicyclic gear train, as shown in figure 8b, the number of teeth on wheels A, B, and C are 50, 25, and 52 respectively. If the arm rotates at 420rpm cw, find

   (a) speed of wheel C when A is fixed, and

   (b) speed of wheel A when C is fixed. [16]

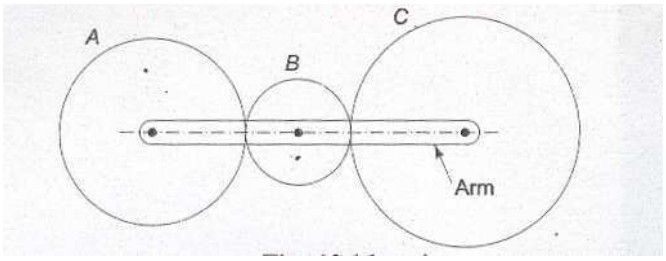


Figure 8b

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Code No: R05310304 **Set No. 4**

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1. (a) What is a Kinematic pair? Explain different types of Kinematic pairs as classified by relative motion.
   (b) The distance between the axes of two parallel shafts is 1cm. The shafts are connected by Oldham coupling. Find the maximum Kinetic energy of the intermediate piece of mass 5 kg when the shafts revolve at 300rpm. [10+6]

2. In Robots mechanism shown in figure 2 the ends of two links AB and CD are fixed as shown in figure . The lengths of the links are such that AB=CD=BE=ED and BD= $\frac{1}{2}$ AC. For small displacements of the cranks, show that the point E will move in an approximate straight-line. [16]

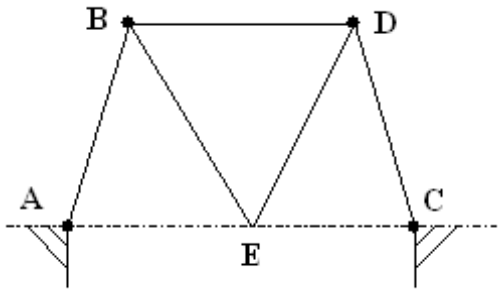


Figure 2

3. The crank OP of a crank and slotted lever mechanism shown in figure 3. rotates at 200 rpm in the counter-clockwise direction. Various lengths of the links are OP = 90 mm, OA = 300 mm, AR = 480 mm and RS= 330mm. The slider moves along an axis perpendicular to AO and is 120 mm from O. Determine the velocity of the slider when the angle AOP is $135^o$ and also the maximum velocity of the slider. [16]

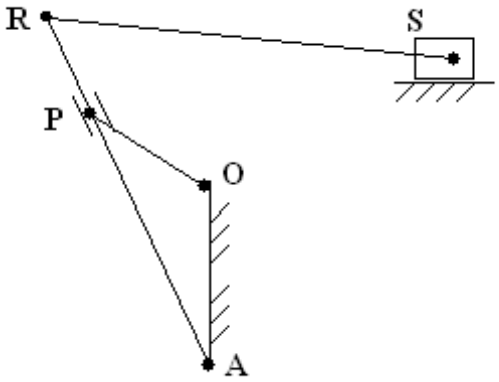


Figure 3

4. (a) What conditions must be satisfied by the steering mechanism of a car in order that the wheels may have a pure rolling motion when rounding a curve? Deduce the relationship connecting the inclinations of the front stub axles to the rear axle, the distance between the pivot centers for the front axles and wheelbase of the car.

   (b) A Hooke's joint connects a shaft running at a uniform speed of 1200 rpm to a second shaft, the angle between their axes being 20 degrees. Find the velocity and acceleration of the driven shaft at the instant when the fork of the driving shaft has turned through an angle of $15^o$ from the plane containing the shaft axes. At what positions of the driving shaft during a revolution, the angular velocity of the driven shaft is the same as that determined above? [8+8]

5. (a) Define the terms prime circle, pitch circle, base circle of a cam.

   (b) Draw the profile of a cam which is to give oscillatory motion to the follower with uniform angular velocity about its pivot. The base circle diameter is 50mm, angle of oscillation of the follower $30^0$ and the distance between the cam centre and the pivot of the follower 60mm. The oscillating lever is 60mm long with a roller of 8mm diameter at the end. One oscillation of the follower is completed in one revolution of the cam. [16]

6. (a) Describe various types of gears used for connecting parallel shafts?

   (b) The velocity ratio of two spur gears in mesh is 0.4 and the centre distance 75mm. For a module of 1.2mm, find the number of teeth of the gears. What will be the pitch line velocity if the pinion speed is 800 rpm? Also find the speed of the gear wheel. [4+12]

7. An open belt drive connects two pulleys 1.5m and 0.5m diameter on parallel shafts 3.5m apart. The belt has a mass of 1 kg/m length and the maximum tension in the belt is not to exceed 2kN. The 1.5m pulley, which is the driver, runs at 250 rpm. Due to belt slip, the velocity of the driven shaft is only 730rpm. If the coefficient of friction between the belt and the pulley is 0.25, find

   (a) torque on each shaft

(b) Power transmitted,

(c) power lost in friction, and

(d) efficiency of the drive. [16]

8. Figure 8 shows an epicyclic gear train arrangement. Wheel E is a fixed wheel and wheels C and D are integrally cast, and mounted on one pin. If the arm A makes one revolution/sec. counter-clockwise, determine the speed and the direction of rotation of wheels B and F. [16]

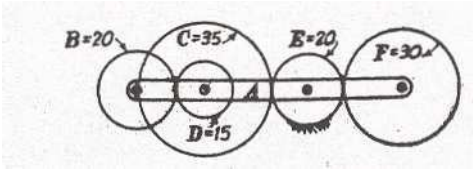


Figure 8

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